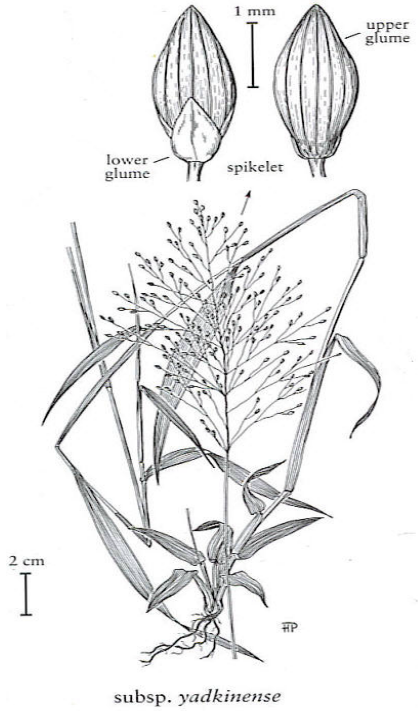
Conservation Assessment

for the

Yadkin Panicgrass

(Dichanthelium dichotomum subsp. yadkinense (Ashe) Freckmann & Lelong)



Steven R. Hill, Ph.D.

Division of Biodiversity and Ecological Entomology
Biotic Surveys and Monitoring Section
1816 South Oak Street
Champaign, Illinois 61820

ILLINOIS NATURAL HISTORY SURVEY

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Dichanthelium dichotomum subsp. *yadkinense* (Ashe) Freckmann & Lelong, from Freckmann, R.W. and M. G. Lelong. 2003. 25.09 *Dichanthelium* (Hitchc. & Chase) Gould, p. 435 *In* M.E. Barkworth *et al.* (eds.) 2003. Flora of North America North of Mexico. Volume 25 Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Oxford University Press: New York.

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EXECUTIVE SUMMARY

This Conservation Assessment is a review of the taxonomy, distribution, habitat, ecology, and status of the Yadkin Panicgrass, *Dichanthelium dichotomum* subsp. *yadkinense* (Ashe) Freckmann & Lelong, throughout the United States and Canada, and in the U.S.D.A. Forest Service lands, Eastern Region (Region 9), in particular. This document also serves to update knowledge about potential threats to, and conservation efforts regarding, the Yadkin Panicgrass to date. *Dichanthelium dichotomum* subsp. *yadkinense* (= *Dichanthelium yadkinense*) is not always recognized as a distinct grass, and it has usually been thought of as a part of the variable species *Dichanthelium dichotomum*. When considered distinct, it is defined as a clumped perennial grass up to approximately 1 meter tall with broad leaves, and it is normally found in moist or wet sandy soils in shade in floodplain forests or low upland forests near creeks in twenty-one states ranging from Pennsylvania and Illinois south to Florida and Texas. The plants have a spring-flowering stage and a morphologically different late summer and autumn flowering stage, and they have a wide-leaved basal rosette in the winter months. While normal wind-pollinated flowers are present in the spring, late summer flowers self-pollinate and normally do not open. It has been listed as Endangered in Illinois and Ohio, and as Threatened in Indiana, and as At Risk in the Shawnee National Forest of Illinois, the Hoosier National Forest in Indiana, and the Mark Twain National Forest in Missouri. A great deal of additional research is needed to better evaluate the status and distribution of this grass.

In addition to species listed as endangered or threatened under the Endangered Species Act (ESA), or species of Concern by U.S. Fish and Wildlife Service, the Forest Service lists species that are Sensitive within each region (RFSS). The National Forest Management Act and U.S. Forest Service policy require that National Forest System land be managed to maintain viable populations of all native plant and animal species. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the entity throughout its range within a given planning area.

The objectives of this document are to:

-Provide an overview of the current scientific knowledge on the subspecies.

-Provide a summary of the distribution and status on the subspecies range-wide and within the Eastern Region of the Forest Service, in particular.

-Provide the available background information needed to prepare a subsequent Conservation Approach.

NOMENCLATURE AND TAXONOMY

Scientific Name:	*Dichanthelium dichotomum* (L.) Gould subsp. *yadkinense* (Ashe) Freckmann & Lelong [2002]
Common Names:	Yadkin Panicgrass; Yadkin Panic Grass, Yadkin River Panic-grass; Spotted Panic-grass, Spotted-sheath Panic Grass; Carolina Panic Grass.
Synonymy:	*Panicum maculatum* Ashe, non Aubl., *nom. illegit.* [1898] *Panicum yadkinense* Ashe [*nom. nov.* – 1900] *Panicum dichotomum* L. var. *yadkinense* (Ashe) Lelong [1984] *Dichanthelium yadkinense* (Ashe) Mohlenbr. [1985] Often included within: *Dichanthelium dichotomum* (L.) Gould var. *dichotomum*

Class:	Liliopsida (Flowering Plants - Monocotyledons)
Family:	Poaceae (= Gramineae; The Grass Family)
Plants Code:	DIDD [and as synonyms DIYA, PADIY, PAYA2] (USDA NRCS plant database, W-1) http://plants.usda.gov/

The grass genus *Dichanthelium* contains about 34 species in North America north of Mexico, according to Freckmann and Lelong (2003). The genus is of average to just above average size within the flowering plants with about 72 species worldwide. The species are limited to the Americas, and are most common in wet or moist, temperate to warm temperate regions of the Northern Hemisphere. *Dichanthelium* was segregated from the much larger, and very similar genus, *Panicum* first as a subgenus (*Panicum* subg. *Dichanthelium* Hitchc. & Chase [1910]) and subsequently as a genus (*Dichanthelium* (Hitchc. & Chase) Gould [1974]). A thorough review of this history, and support for the genus as being distinct, can be found in Aliscioni *et al.* (2003). The genus is placed within the grass subfamily Panicoideae tribe Paniceae.

Yadkin Panicgrass was first named *Panicum maculatum* by Ashe in 1898 because of the distinctive pale spots on its leaf sheaths (‘*macula*’ in Latin = spot). However, this name had already been given to a plant in French Guiana by Aublet much earlier in 1775, and so Ashe in 1900 renamed the grass *Panicum yadkinense*, because specimens had been collected by him in Yadkin County, located in the foothills of North Carolina along the Yadkin River, or Yadkin Valley, hence the epithet *yadkinense*. In the subsequent years this grass was often considered to be a minor variant of *Panicum dichotomum* L. [1753] (now *Dichanthelium dichotomum* (L.) Gould) and it was usually combined with that, or it has been treated as a distinct species in the genus *Dichanthelium*, as *Dichanthelium yadkinense* (Ashe) Mohlenbr. It has also been named as a variety of *Panicum dichotomum*, *Panicum dichotomum* var. *yadkinense* (Ashe) Lelong. The taxon’s status will probably be debated for many years to come, because its distinctness can be

considered to fit within the overall known variability of typical *D. dichotomum*, or it can be considered to be a minor morphological variant named var. *yadkinense*, or it can be treated as an incipient geographically distinct species as subsp. *yadkinense*, or the characters can be emphasized to make it distinct at the specific level. This is a matter of taxonomic opinion (varying even in the opinion of the same botanist over time), and its status probably can only be resolved by some committee decision in the future. For now, most botanists in North America will use the name *Dichanthelium dichotomum* subsp. *yadkinense* because this is how it appears in the *magnum opus* The Flora of North America, Volume 25 (Freckmann and Lelong 2003), an attempt to inventory all of the species of plants in North America north of Mexico. The new name combinations that were necessary to rank this grass as a subspecies, along with those of all of the other subspecies, appeared in 2002 (Freckmann and Lelong 2002).

Yadkin Panicgrass has been placed with six other subspecies of *D. dichotomum* within *Dichanthelium* sect. *Dichanthelium* by Freckmann and Lelong (2003) along with the similar species *D. boreale* (Nash) Freckmann. Because of the differing taxonomic philosophies and treatments of floristic botanists over the years, it is somewhat difficult to determine the precise range of this plant from the literature. Illinois botanists have tended to accept its treatment as a species because of floras produced by Mohlenbrock (1986, 2002). Followers of the treatment of Gleason and Cronquist (1991) also consider it to be a species, as *Panicum yadkinense* Nash, and call it by that name.

The other five subspecies are *Dichanthelium dichotomum* (L.) Gould subsp. *dichotomum* [= *Panicum dichotomum* L.], *D. d.* subsp. *lucidum* (Ashe) Freckmann & Lelong [= *Panicum lucidum* Ashe], *D. d.* subsp. *mattamuskeetense* (Ashe) Freckmann & Lelong [= *Panicum mattamuskeetense* Ashe], *D. d.* subsp. *microcarpon* (Muhl. ex Elliott) Freckmann & Lelong [= *Panicum microcarpon* Muhl. ex Elliott], *D. d.* subsp. *nitidum* (Lam.) Freckmann & Lelong [= *Panicum nitidum* Lam.], and *D. d.* subsp. *roanokense* (Ashe) Freckmann & Lelong [= *Panicum roanokense* Ashe]. Among these subspecies, subsp. *dichotomum*, subsp. *mattamuskeetense*, and subsp. *microcarpon* have all been reported from the states of Illinois and Indiana, subsp. *nitidum* has been reported in Illinois but not in Indiana, and subsp. *lucidum* has been reported in Indiana but not in Illinois (Hitchcock and Chase 1951; Freckmann and Lelong 2002, 2003; Mohlenbrock 2002). The subsp. *roanokense* has not been found in the Midwest.

Most species of both *Panicum* and *Dichanthelium* are simply called ‘panic grass’ or ‘panicgrass’ because of their similarity to one another. It is only in recent years that there has been an attempt to standardize the common names of the lesser-known species. The common name for the overall, or broadly defined, species *Dichanthelium dichotomum* has been standardized by Freckmann and Lelong (2003) as Forked Panicgrass (a dichotomy being a fork) but it is often also called Cypress Panicgrass. The subsp. *yadkinense* has been known as Spotted Panic-grass in Ohio, and this is descriptive of the distinctive glandular spots usually present on the leaf sheaths

and stems of most of the plants. In the case of the subspecies *yadkinense*, the common name Yadkin Panicgrass could apply to no other taxon.

DESCRIPTION OF THE SUBSPECIES

Dichanthelium dichotomum subsp. *yadkinens*e, the Yadkin Panicgrass, is a perennial non-rhizomatous cespitose grass with several erect or suberect **stems** (culms) usually 50 – 100 cm tall; the main stems usually have glabrous (especially the lower) or very infrequently sparsely and inconspicuously hairy nodes; the internodes are glabrous and often are yellow-green. The stems are usually unbranched and erect in the spring (vernal) phase and have wide leaves and there is a prominent winter to spring basal rosette present with shorter wider leaves than those of the later summer and autumn elongated stems as in most other *Dichanthelium* species; in the autumnal phase the basal rosette is normally gone and the stems are suberect or leaning and sparsely, loosely branched from the midculm nodes; the leaf blades are narrower than the spring leaves but they not as greatly reduced as in the other subspecies. The **leaf sheaths** of the stem leaves are glabrous (to sparsely hairy along the margins) and often have conspicuous pale glandular spots between the prominent veins. The ligules are 0.2 – 0.8 mm long and are composed of minute white hairs. The **leaf blades** are relatively broad but thin; those of the leaves toward the middle of the main stem are (7-) 10-12 (-15) mm wide and 9-14 cm long, they are broadest at or near the middle, they generally taper to both ends, and they are glabrous on both surfaces (to hairy along the margins near the base). The **panicles** are exserted and 10 – 12 cm long, and the axes are not punctate. The **spikelets** are (1.9-) 2.3-2.5 (-2.6) mm long and up to 1.0 mm broad, elliptic to subfusiform, glabrous, and pointed (acute or beaked) at the tip beyond the fruit itself. The first glume is 0.7 – 1.2 mm long. The single upper floret, or **flower**, bears a pistil and three stamens, and each may produce a single seeded fruit, the caryopsis, enclosed within a smooth hard lemma and palea. The chromosome number is 2*n* = 18 (adapted from Hitchcock and Chase 1951 (as *Panicum yadkinense*), from Yatskievych 1999 (as *Panicum dichotomum* var. *yadkinense*), and from Freckmann and Lelong 2003). An illustration of this subspecies can be found in Freckmann and Lelong (2003) p. 435 and this has also been used as the cover image to this report.

Dichanthelium dichotomum subsp. *yadkinense* can be separated from *Dichanthelium dichotomum* subsp. *dichotomum* and the other subspecies by a series of fairly well defined characters. Mohlenbrock (1986, 2002) distinguished what he called "*Dichanthelium yadkinense*" from *Dichanthelium dichotomum* by the following characters:

Lower nodes bearded; sheaths softly pubescent, spikelets 2.0-2.2 mm……..*D. dichotomum*
Nodes glabrous or sparsely pilose; sheaths glabrous to soft hairy along the margins but not softly pubescent; with pale glandular spots, spikelets 2.2-2.5 mm ……*D. yadkinense*

The Yadkin Panicgrass fits within the greater variation of *Dichanthelium dichotomum* and it is closely related to the other subspecies. However, it is the most distinct of the subspecies and so it is more often recognized as a distinct species than are some of the others. The combination of its pale glandular-spotted leaf sheath (found, apparently, in none of the other subspecies) along with its glabrous lower stem nodes, wide spring leaf blades (> 1 cm), larger spikelets (1.9-2.6 mm) that are pointed beyond the fruit at their tips, and the (often) rather robust habit (to 1 m tall) tend to be diagnostic for this plant. However, it should also be noted that some individuals apparently lack the glandular spots, and some of the other subspecies can grow to 1 m tall (*e.g.*, subsp. *microcarpon*, subsp. *nitidum*, subsp. *roanokense*), and the spikelets of some other subspecies can overlap in size within the 1.9 – 2.5 mm range (though they are usually less than 2.2 mm and they are relatively blunt-tipped). Therefore, the combination of characters is more important than the individual characters to separate the subspecies. Illinois specimens that were examined and thought to be subsp. *yadkinense* consistently lacked tufts of hairs at the stem nodes, they had conspicuous pale wart-like glands on the leaf sheaths and sometimes on the culm itself, the leaf sheaths were glabrous or only very sparsely hairy, the ligules were a minute ring of white hairs, and the spikelets were conspicuously pointed (Hill, pers. obs.). The ranges (to be discussed more fully below) of the subspecies overlap in much of the southeastern portion of the United States and south and intergradations among the subspecies are not uncommon (Freckmann and Lelong 2003).

HABITAT AND ECOLOGY

A review of the literature demonstrates that this grass is in a limited variety of habitats throughout its range (Fernald 1950, Hitchcock and Chase 1951, Freckmann and Lelong 2003). *Dichanthelium dichotomum* subsp. *yadkinense* grows mainly in shade in mesic to wet forests especially along creeks (Fernald 1950 [rich or damp woods, thickets, bottomlands, and swamps], Freckmann and Lelong 2003 [rich moist or wet woods], Herkert and Ebinger 2002 [mesic forests, wet soil and gravelly stream beds]), and it appears to be somewhat cold sensitive, especially as compared to the typical subspecies, based on its known range.

Little information is available concerning its soil or pH preferences, but it apparently prefers moist or wet sandy soil and other alluvium in creek bottoms or on creek banks, and herbarium labels suggest that the substrates may be acidic or circumneutral rather than basic. Basinger (2003) reported the pH at one known locality to be 6.3 +/- 0.1, and the soil depth averaged less than 10 cm; the site was said to be facing east-northeast and heavily shaded. In Missouri, the substrate is said to be over igneous rock (Yatskievych 1999), but in Illinois this grass appears to be more commonly associated with sandstone. In an article by Estes and Walck (2005) the habitat of this grass (as *Dichanthelium yadkinense*) was said to include moist to wet stream banks and calcareous seeps in Tennessee, certainly an exception to the idea that the substrate is normally acidic for this grass. Pohl (1947) stated that this grass is characteristically found in

serpentine barrens in Pennsylvania, but that it is not restricted to them.

Specific information on herbarium specimen labels of this grass provides additional details. In Arkansas, this grass was said to grow in 'sandy shaded ground along a small creek', in Georgia it was found in a swamp alongside a river, in Kentucky the habitat was described as the 'edge of a wet area on igneous mica-peridotite dike along' a creek. In Maryland the habitat has been described on herbarium labels as 'open wet fields' along a creek, as a 'damp wooded ravine', and as in 'woods' along a creek. In South Carolina the habitat was described as a 'sandy river bottomland …on stream bank', and in Tennessee as 'alluvium of creek bottom, shaded area'. In Virginia, the habitat of the Yadkin Panicgrass was described as 'wooded alluvial bottomland' of a creek, as 'shady mixed-hardwood woods with low wet areas', as 'open sandy borders of pools and depressions, bottomland of' a river, and as 'flat pinelands east of [creek], recent gravel pit'. The habitat details differ a little from those of the typical subspecies. *Dichanthelium dichotomum* subsp. *dichotomum* normally grows in mesic or dry-mesic deciduous or mixed forests, thickets and openings, often in sandy or rocky open areas (Freckmann and Lelong 2003, Magee and Ahles 1999). The other five subspecies, however, also prefer moist to wet, often sandy habitats (Freckmann and Lelong 2003).

Because this subspecies is not recognized as distinct in most official federal listings of the plants of North America, it has not been given an official wetland status. The overall and inclusive species that includes the Yadkin Panicgrass in those lists, *Dichanthelium dichotomum*, has been given the national wetland indicator status of FAC (Facultative) and FAC- (somewhat less than Facultative) indicating that the species is equally likely to occur in wetlands or non-wetlands, or that it is slightly more likely to be found in non-wetlands. In Wetland Region 3, including both Illinois and Indiana, *Dichanthelium dichotomum* [in the broad sense] has been specifically designated as an FAC- species (slightly less likely to occur in wetlands than in non-wetlands, the probability is less than 34% that it will occur in wetlands; Reed 1988; W-1; W-2). The subspecies *yadkinense* appears to fit this pattern, though it does appear to be slightly more correlated to wetlands than the overall species classification suggests, and it would appear that FAC would better apply to this subspecies. Godfrey and Wooten (1979) included *Panicum yadkinense* within *Panicum dichotomum* in their work on aquatic and wetland plants of the southeastern United States and so the more specific preferences of subsp. *yadkinense* cannot be determined from that important wetland plants treatment.

Because this grass has not always been distinguished from *Dichanthelium* (*Panicum*) *dichotomum* in floras throughout its range, relatively little has been published concerning its ecology and plant associates. Until more fieldwork has been conducted on specific, identified populations of this grass, the more detailed aspects of the ecology and specific lists of its plant associates will remain somewhat speculative in portions of its range. On one Maryland specimen label, it was indicated that the Yadkin Panicgrass commonly grew among individuals

of *Dichanthelium* (*Panicum*) *clandestinum* (L.) Gould, and it appears that it often grows with similar *Dichanthelium* species.

In Illinois, the Yadkin Panicgrass grows in wet sandy soils in mesic forests and along gravelly stream banks or seep springs at the southern tip of the state most notably within Pope County in the Shawnee National Forest (Basinger 2003; Herkert and Ebinger 2002, Shawnee National Forest 2005). Other plants that are known to grow in the general vicinity of this grass at its known locations generally include the **trees** *Acer rubrum, Acer saccharinum, Carya illinoensis, Celtis laevigata, Fagus grandifolia, Fraxinus americana, Nyssa sylvatica, Populus deltoides, Quercus macrocarpa, Salix nigra,* and *Ulmus rubra*; the **shrubs** *Alnus serrulata, Cornus obliqua, Cornus stricta, Hypericum prolificum, Ilex verticillata,* and *Viburnum dentatum*; the **vine** *Smilax glauca*; the **forbs** *Boehmeria cylindrica, Claytonia virginica, Collinsonia canadensis, Dentaria laciniata, Desmodium paniculatum, Eupatorium fistulosum, Impatiens capensis, Lysimachia lanceolata, Phlox paniculata, Pilea pumila, Polygonum sagittatum, Saururus cernuus, Sedum ternatum, Solidago caesia, Solidago patula, Tradescantia aspera, Uvularia sessilifolia,* and *Zizia aurea*; the **graminoids** *Andropogon gerardi, Arundinaria gigantea, Brachyelytrum erectum, Carex albicans, Carex albursina, Carex digitalis, Carex grayi, Carex jamesii, Carex retroflexa, Carex rosea, Carex virescens, Dichanthelium boscii, Dichanthelium polyanthes, Elymus riparius, Leersia lenticularis, Leersia oryzoides,* and *Muhlenbergia sobolifera*; and the **ferns** *Athyrium angustum, Botrychium virginianum, Dryopteris marginalis,* and *Osmunda cinnamomea*. These would be the expected associates in most portions of the range of this grass. The known populations of this rare grass are located in the Greater Shawnee Hills Section of the Shawnee Hills Natural Division of Schwegman *et al.* (1973) adjacent to the Lesser Shawnee Hills Section of the same natural division, and it has also been found within the Cretaceous Hills Section of the Coastal Plain Division. It may also occur in the Bottomlands Section of the Coastal Plain Division.

In North Carolina, *Dichanthelium dichotomum* subsp. *yadkinense* has been reported to occur in two similar plant communities, the Blackwater Levee / Bar Forest, and the Sand and Mud Bar, habitats alongside rivers (in one case along the Little River - Sorrie *et al.* 2006; Schafale and Weakley 1990). In these two adjoining plant communities the associated **trees** can include *Acer rubrum, Betula nigra, Carpinus carolinianus, Fraxinus caroliniana, Ilex opaca, Liquidambar styraciflua, Pinus taeda, Quercus nigra,* and *Quercus lyrata*. Associated **shrubs** can include *Alnus serrulata, Cephalanthus occidentalis, Cornus foemina* (± = *Cornus stricta*) , *Cyrilla racemiflora, Itea virginica, Sambucus canadensis,* and *Vaccinium elliottii*. Associated **vines** can include *Bignonia capreolata, Campsis radicans, Mikania scandens, Smilax* spp., *Trachelospermum difforme,* and *Vitis* spp. **Forbs** are diverse, and these can include *Amsonia tabernaemontana, Diodia virgininana, Elephantopus carolinianus, Gratiola neglecta, Houstonia purpurea, Hypoxis curtissii, Lobelia elongata,* and *Polygonum* spp., among others. **Graminoids** are also common, and, along with *Dichanthelium dichotomum* subsp. *yadkinense,* these can

include *Arundinaria gigantea*, *Carex crebriflora*, *Dichanthelium polyanthes*, *Panicum hemitomon*, *Panicum hians*, *Panicum rigidulum* var. *elongatum*, and *Saccharum baldwinii*.

DISTRIBUTION AND ABUNDANCE

Dichanthelium dichotomum subsp. *yadkinense*, the Yadkin Panicgrass, is somewhat limited in range and it is thought to be endemic to the eastern United States, generally in the eastern and southeastern states. Its precise range is difficult to determine because of the fact that many botanists have not distinguished it from the widespread *Dichanthelium* (*Panicum*) *dichotomum*. Among the most important national references, Kartesz and Meacham (1999) decided to include this subspecies within the typical one. The United States federal plant name lists also do not accept this plant as distinct because they have based their nomenclature on that of Kartesz as a means of standardization. In the literature, however, subsp. *yadkinense*, under various names, has been determined to be native generally from New Jersey and Pennsylvania to southern Illinois and southeastern Missouri, south to Georgia, Louisiana, and Texas (Gleason and Cronquist 1991, Freckmann and Lelong 2003, Yatskievych 1999). Based on available data, the Yadkin Panicgrass has occurred historically in the eastern United States in Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and West Virginia (Hitchcock & Chase 1951, Freckmann and Lelong 2003). This is a total of twenty-one states plus the District of Columbia. The reports in New Jersey appear to be historic only, and no populations are known to exist currently in that state (W-3). This grass has been reported to occur in Michigan, but according to Voss (1972), these reports were based upon misidentified specimens of the subsp. *lucidum*. Only two locations are known in Ohio, one from Scioto County dating pre-1960 and one from Jackson County collected after 1960 but since relocated; in 1980 the subspecies was designated as Extirpated in the state, but it is currently listed as Endangered in Ohio (W-4). The Yadkin Panicgrass appears to be most frequent in North Carolina, Tennessee, and Virginia, based on available data.

Among the other six subspecies currently recognized, the range of subsp. *dichotomum* is the largest, and it extends from southern Ontario in Canada, to Maine and south through Illinois and Missouri to eastern Texas, and to the east coast of the United States and central Florida, and possibly into Mexico. The relatively common subsp. *lucidum* is a coastal plain subspecies, ranging from New Jersey to Florida, southeastern Texas, up the Mississippi embayment to western Tennessee and, as a disjunct, on the Indiana Dunes of Lake Michigan. The less common subsp. *mattamuskeetense* (Ashe) Freckmann & Lelong is another coastal plain taxon occurring from Massachusetts to Florida, and there is a disjunct occurrence in southern Indiana and Illinois. The widespread subsp. *microcarpon* (Muhl. ex Elliott) Freckmann & Lelong extends from southern Michigan to Massachusetts and south to eastern Oklahoma and Texas and throughout

the southeast to central Florida; this may be the most common subspecies in Illinois. Another coastal plain taxon is subsp. *nitidum* (Lam.) Freckmann & Lelong, and it also occurs on the coastal plain from Virginia to southeastern Texas and Florida, and there is a disjunct population in southern Illinois and Missouri. Finally, the uncommon subsp. *roanokense* (Ashe) Freckmann & Lelong grows on the coastal plain from Delaware to southeastern Texas and it is also in the West Indies (Hitchcock & Chase 1951, Freckmann and Lelong 2003).

The overall, inclusive species *Dichanthelium dichotomum* (*s.l.* [*sensu lato*]) has been reported from at least 34 states plus the District of Columbia, namely, Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia, and Wisconsin (W-1, W-5; Freckmann and Lelong 2003). It has also been found in the West Indies, in Canada (in the provinces of New Brunswick, Nova Scotia, Ontario, and Quebec) and it is relatively widespread in Mexico (Chiapas, Guerrero, Hidalgo, Mexico, Oaxaca, Puebla, Quintana Roo, and Veracruz; Gould 1980). Gould (1980) cited *Panicum yadkinense* as a synonym of *Dichanthelium dichotomum*, but he did not distinguish it at any rank, therefore it is unknown if the subsp. *yadkinense* is in Mexico or not.

The Yadkin Panicgrass is at its northwestern limit of distribution in southern Illinois and southeastern Missouri. In Illinois, where it is listed as Endangered, the subspecies (as a species) has been reported historically in Johnson and Pope counties, and it is thought by most local botanists to occur today only in Pope County in the Shawnee National Forest (see below; Mohlenbrock and Ladd 1978 – as *Panicum yadkinense*; Herkert and Ebinger 2002 as *Panicum yadkinense*; Illinois Endangered Species Protection Board 2005 as *Dichanthelium yadkinense*; Shawnee National Forest 2005 as *Dichanthelium yadkinense*). Within the Shawnee National Forest, the Yadkin Panicgrass has been found in the Lusk Creek Canyon Ecological Area, the Lusk Creek Canyon Zoological Area, the Lusk Creek Wilderness Area, the Double Branch Hole Ecological Area, and, historically, within the Snow Springs Ecological Area (where it was reported in 1969; Shawnee National Forest 2005). A recent collection (2005) was made by John Schwegman in the big seep at the Cretaceous Hills Nature Preserve, also in Pope County. The southern Illinois sites fall just south of the Pleistocene glacial boundary.

It should be noted here that the Illinois distribution is actually quite uncertain at this time. As stated above, the Yadkin Panicgrass is generally accepted to exist today only in Pope County, and it has been generally accepted that it also grew in Johnson County (Herkert and Ebinger 2002). However, according to Mohlenbrock and Ladd (1978), this grass has been recorded in Jackson, Johnson, Hardin, and Pope counties. According to another database on the plants of Illinois (W-6) this grass (as *Dichanthelium yadkinense*) has been reported from six Illinois

counties, namely, Gallatin, Hardin, Jackson, Johnson, Pope, and Union counties. The Illinois Natural History Survey Herbarium in Champaign (ILLS) had no specimens annotated as this grass at any rank until recently, and so the location of vouchers for the records in some of the counties is uncertain. Among the ILLS specimens, four specimens that appeared to have most of the characters of the subspecies were found (Hill, pers. obs) and these were collected in Massac and Pope counties.

The Yadkin Panicgrass was first reported in Missouri in 1993 (Heumann 1993) and it is known there only in Reynolds County in mesic upland forests and the bases of bluffs on igneous substrates (Yatskievych 1999).

This grass also occurs in neighboring Indiana as a threatened species on the slopes and bases of mesic forested hills in the extreme southern portion of the state (Homoya, pers. comm., Deam 1940). It has also been found in neighboring Kentucky but not in Wisconsin. There may very well be more occurrences than have been reported because only a few botanists have attempted to distinguish it from typical *Dichanthelium dichotomum*, and additional specimens may exist in herbaria under that or another name.

The northern historic range limits of this grass subspecies appear to be in southeastern Pennsylvanian and adjacent New Jersey, and in southeastern Ohio. Its southern and western limits appear to be in eastern Texas. Gould placed *Panicum yadkinense* into synonymy with *Dichanthelium dichotomum* in his treatment of the grasses of Texas (Gould 1975) and so provided no additional detail on the range of the subspecies itself.

Within the U.S. Forest Service Eastern Region (Region 9) *Dichanthelium dichotomum* subsp. *yadkinense* (as *Dichanthelium yadkinense*) is known to be present within the Shawnee National Forest in Illinois, the Hoosier National Forest in Indiana, and within the Mark Twain National Forest in Missouri (W-7) in each of which it is considered to be sensitive and at risk. The subspecies has not been reported, as far as is known, in other National Forests within the United States, but it undoubtedly occurs in several. As stated previously, its range is not well known because the subspecies is generally reported either as *Panicum dichotomum* or as *Dichanthelium dichotomum*, a widespread species overall, and only a few people have investigated this plant as a distinct subspecies or species. The broadly defined species is well known to be present in several National Forests in the eastern and southeastern United States.

The populations in Illinois and other parts of the Midwest are isolated from one another, and there is little specific data available regarding population sizes. In South Carolina at one location it was said to be ‘fairly common in woods on stream bank’. In Maryland it was described as being ‘in large tufts of 20-30 culms…the culms reclining’. Another label on a specimen from Virginia stated that the grass was ‘fairly common’. It is likely that the subspecies was only

slightly more common in the region at the time of European settlement because the amount of suitable habitat available then was also limited.

Representative specimens of this grass in the United States have been listed in this report in Appendix 1. A summary of the distribution of the Yadkin Panicgrass in the United States, though very imperfectly known, has been presented in Appendix 2.

PROTECTION STATUS

The Nature Conservancy has not ranked *Dichanthelium dichotomum* subsp. *yadkinense* because it has decided that it is not distinct from *Dichanthelium dichotomum* (W-5). Therefore, there is no global, national, or state ranking available for the Yadkin Panicgrass unless given by individual states. The grass has been listed as Endangered in Illinois (as *Dichanthelium yadkinense* 'Panic Grass'- Illinois Endangered Species Protection Board 2005) and Ohio (as *Panicum yadkinense*; W-4, and this latter site oddly lists *D. dichotomum* var. *dichotomum* as a synonym!), and it has been listed as threatened in Indiana (as *Panicum yadkinense*; formerly as Endangered; Homoya, pers. comm.). In Delaware, this grass (as *Dichanthelium yadkinense*) has been included in the state list of rare species, and it has been given a state ranking of S1 in that list (McAvoy 2003). In Pennsylvania, the Yadkin Panicgrass (as *Panicum yadkinense*) has been treated as an S2 species, but with an unknown taxonomic status (TU, W-8). Pennsylvania, and possibly others, have also cited the global rank of this plant as G3G4Q (the 'Q' indicates that the classification is uncertain). Missouri has ranked this subspecies as an S1 plant, and the global rank there was listed as G5T3T4Q (W-9). The global ranks appear to have been created by state agencies and not by the Nature Conservancy.

The overall inclusive species *Dichanthelium dichotomum* has been ranked, and its global ranking is G5 (Secure; W-5, W-10, Appendix 3). In the United States the overall species is given the National Heritage status rank of N5 with a similar meaning, and in Canada *Dichanthelium dichotomu*m var. *dichotomum* has been given the rank of N2, Nationally Imperiled. The state rankings vary, and in most states the species is not ranked. The broadly defined species has <u>not</u> been designated as sensitive in any state.

Dichanthelium dichotomum subsp. *yadkinense* (as *Dichanthelium yadkinense*) has been included on the Regional Forester Sensitive Species list (RFSS) for the Eastern Region, and it is classified to be 'At Risk' on the Shawnee National Forest in Illinois, The Hoosier National Forest in Indiana, and on the Mark Twain National Forest in Missouri (W-7).

Protection for this grass is currently dependent primarily on habitat protection, and so its survival will probably depend more on this than on species protection. While this can sometimes be considered to be a wetland grass, at several, perhaps most, of its known locations the habitat may

no longer qualify as a wetland by federal standards and it may not be protected in the long term by wetland legislation.

Table 1 lists the official state rank assigned by each state's Natural Heritage program to the broadly defined species *Dichanthelium dichotomum*, according to the Nature Conservancy at their Internet site (W-5). It should be noted that these ranks do not (unless otherwise noted) specifically apply to subsp. *yadkinense*, which has no such ranking, but the table can serve as some guide for the overall species itself. Appendix 3 explains the meanings of the acronyms used (W-10). A summary of the current official protection status for the Forked Panicgrass [and **NOT** the Yadkin Panicgrass, except where noted] follows:

U.S. Fish and Wildlife Service: Not listed (None)

U.S. Forest Service: *Dichanthelium dichotomum* is not listed as sensitive. As *Dichanthelium yadkinense* this grass is sensitive and At Risk in Region 9 in the Shawnee National Forest, the Hoosier National Forest, and the Mark Twain National Forest.

Global Heritage Status Rank: G5

U.S. National Heritage Status Rank: N5

Table 1: S-ranks for *Dichanthelium dichotomum, s.l.* [Heritage identifier: PMPOA240B0]. * = subsp. *yadkinense* known to occur in the state.

State / Province	Heritage S-rank
UNITED STATES	
*Alabama	SNR
*Arkansas	SNR
Connecticut	S5
*Delaware	S5 [subsp. *yadkinense* 'Rare', S1]
*District of Columbia	SNR
*Florida	SNR
*Georgia	S5
*Illinois	S4 [subsp. *yadkinense* - Endangered]
*Indiana	SNR [subsp. *yadkinense* – Threatened – S2]
Iowa	SNR
Kansas	S1
*Kentucky	SNR
*Louisiana	S5
Maine	SNR
*Maryland	SNR [subsp. *yadkinense*, a Species of Concern]
Massachusetts	SNR
Michigan	SNR
Minnesota	SNR

*Mississippi	SNR	*South Carolina	SNR
*Missouri	SNR [subsp. *yadkinense* as S1	*Tennessee	SNR
		*Texas	SNR
New Hampshire	SNR	Vermont	S3
*New Jersey	SNR [subsp. *yadkinense*, SH]	*Virginia	S5
		*West Virginia	S5
New York	S4	Wisconsin	SNR
*North Carolina	S5		
*Ohio	SNR [subsp. *yadkinense* - Endangered]	**CANADA**	
		New Brunswick	S1
Oklahoma	SNR	Ontario	S2
*Pennsylvania	SNR	Quebec	SU
Rhode Island	SNR		

LIFE HISTORY

Dichanthelium dichotomum subsp. *yadkinense* is a native perennial grass that lives to an unknown age. It is somewhat delicate, and so it may not be especially long-lived, but individual plants may continue to multiply by means of continued outward (radial) growth or clump divisions for a considerable time. Colonies of the subspecies may be common locally. It appears to flower regularly, and, as in many other *Dichanthelium* species, the earliest flowering panicle appears to only infrequently produce significant numbers of mature fruits, while the later lateral and smaller panicles throughout the plant appear to produce cleistogamous flowers (flowers that do not open completely and which self-pollinate) that regularly and reliably produce viable fruits / seeds. The spring flowers are wind-pollinated as in almost all other grasses. The lack of mature fruits in many of these spring panicles may be due to the still-air habitat within floodplain forests and forested swamps that may prevent much successful pollen spread. Nothing is known concerning the success of establishment of new individuals from seed, nor about the genetic variability within or between colonies of this subspecies.

The Yadkin Panicgrass is a member of a group of plants that utilize a very efficient photosynthetic pathway called the C3 pathway, the initial fixation product of which is 3-phosphoglyceric acid (Brown and Smith 1975). Most plants, including the true genus *Panicum*, use a less efficient carbon production cycle called the C4 pathway. Grasses such as those in the genus *Dichanthelium* and many monocot and dicot weeds that utilize the C3 pathway tend to grow quickly and reproduce quickly and abundantly.

The typical *Dichanthelium* plant has two distinct growing phases. Growth in the spring is rapid from a basal rosette of rather wide, low leaves, and one relatively large panicle of flowers is

produced at the tip of each tall stem (culm) produced from the rosette; there are normally multiple stems produced per clump. While these flowers are bisexual and a great deal of pollen is produced and released into the air, only a limited number of mature fruits are typically produced at this season. A second rapid flush of growth occurs in the late summer and autumn, generally after rains, and the original culms begin to branch and re-branch to produce a series of short clustered lateral and terminal stems that are often congested and each can produce several small panicles in their axils. These panicles consist largely of flowers that are also bisexual but that do not completely open, but, instead, the pollen is released onto the stigma within its own flower, and most flowers result in mature fruits. These closed flowers are generally termed cleistogamous flowers, and the production of these many seeds insures the propagation of the species.

These two flowering stages look quite different from one another, and the differences can present difficulties for many who attempt to identify these plants for the first time. In the spring, or vernal, phase one finds a plant with a conspicuous rosette of basal leaves, along with rather robust stems also with rather wide leaves, each stem terminating in a single easily seen panicle. The summer – autumn, or autumnal phase plant has lost its green basal rosette and has a number of broom-like fascicles of small branches with tiny panicles and several seeds that look only slightly like its earlier form. At the end of the season, a rosette again forms, and this basal rosette remains green throughout the winter, making and storing nutrition for a rapid flowering again the following spring. In order to flower successfully in the spring, this rosette must be kept free of debris such as leaf fall and snow in order to photosynthesize throughout much of the winter (Hill, pers. obs.). This requirement serves to restrict its habitat and range. *Dichanthelium dichotomum* subsp. *yadkinense* is one of many species and subspecies that follow this typical life history pattern. This successful reproduction pattern usually results in a thriving colony of densely clumped individuals over time in a suitable habitat.

The Yadkin Panicgrass does not appear to produce elongated rhizomes and so there is no evidence as yet that the plant can spread significantly by vegetative means. Theoretically, more plants can result from the division of the plants by vegetative reproduction, and many grasses are well known to steadily grow outward from the center point as the center dies, resulting in a ring-like colony. In the field, however, the Yadkin Panicgrass is usually found as separate, distinct, and rather large mounded clumps rather than a series of small separated propagating individuals of a single clone. Instead of vegetative reproduction, it is more likely that this grass has spread very slowly throughout the southeastern states along slow-moving rivers by means of a gradual dispersal by flooding, or by a simple gradual expansion of its range. The small smooth fruits have no known specialized dispersal mechanism.

The Yadkin Panicgrass has been found in flower as early as 26 May in Illinois; its vernal phase is generally seen from about 29 May to 25 June, quickly followed by mature fruits until about 30

July, by which time most vernal seeds or flowers have fallen. The fastigiated autumnal phase soon follows and the plants can continue to flower and fruit until late September and early October (W-4) but few specimens of the autumnal phase are in herbaria. In Missouri, the vernal phase is said to be fertile (flowering) in May-June and the autumnal phase is said to be fertile from July-October (Yatskievych 1999). Because of the lack of verified specimens, this range of dates may be incomplete, as many other *Dichanthelium* species actually begin to flower by the end of April in the vernal phase. Most (75 %) of the relatively few herbarium specimens examined for this report were collected in June and July. Vernal flowers were most obvious on specimens collected from 29 May – 7 June, mature fruits were on plants from 29 May – 19 July, and old or fallen fruit were evident on plants collected 7 July to August 18. Autumnal fruits became prominent at about 24 August.

Based upon its phenology and known distribution, this grass appears to prefer and thrive in warm, moist weather or climates and its range appears to be limited by drought, lack of shade, and by extreme cold. It does not appear to grow in strictly calcareous or basic soil habitats very often (it prefers acidic substrates) it is not found in full sun, and it requires moist to wet soil all year.

POPULATION BIOLOGY AND VIABILITY

Dichanthelium dichotomum subsp. *yadkinense* flowers regularly, and according to the pattern described in the previous section, in Illinois and elsewhere throughout in its range. It appears to spread primarily or exclusively by means of seeds, but there is no data available on its fertility. It is known in most *Dichanthelium* species that outcrossing can theoretically occur during the vernal phase of growth, yet most seeds are actually produced later in the season through a process of self-pollination and fertilization. This can lead to some serious reproductive problems caused by inbreeding if this is also true in the Yadkin Panicgrass.

It is generally understood that fertility is reduced in inbred populations through the process of autogamy (self-fertilization). Autogamy is useful to the plant when there are small numbers of individuals per area, since the safeguarding of the success of propagation is more important than the production of new genotypes. In primary habitats, *i.e.*, those that are generally poorly vegetated, initial success is very important. However, in subsequent periods of vegetation increase, pioneers are often substituted by other, more competitive species (W-11). In plants such as the Yadkin Panicgrass, self-fertilization is typical because there is usually little chance of fertilization by other individuals or genotypes. Not only does the pollen probably not disperse well by wind in its typical habitat, but also the majority of the fruits produced may be the result of self-pollinating cleistogamous flowers with no outcrossing potential. It can be shown that existing populations are very isolated from one another because of the discontinuous nature of their habitat. Continued self-fertilization in such plants can result in severe reproductive

problems.

An example of negative effects thought to have arisen through isolation of populations can be seen in the case of another grass, Ofer Hollow Reedgrass (*Calamagrostis porteri* ssp. *insperata* (Swallen) C.W.Greene), which has become isolated on rather dry sandstone bluffs throughout its range. This grass almost never produces viable seed anywhere in its range and this reproductive failure may be a reflection of a high genetic load that has occurred as a result of its long isolation (see Hill 2003). High genetic load can be seen in dominant mutations that result in factors lethal to embryos, and this situation appears to be indicated in that grass. That plant survives as a rare relict in the vegetative state only.

There is no data at this time on the fertility of the seeds produced in the Illinois populations of the Yadkin Panicgrass. It is a vulnerable subspecies in Illinois and there is not enough information available to determine if this grass is secure in other areas with suitable habitat remaining either. Whether it persists or not in the future in areas where it is currently scarce appears to depend on the survival and maintenance of its habitat.

The Yadkin Panicgrass habitat has been observed to be decreasing (see Potential Threats below). It may or may not occur at other suitable sites in Illinois and neighboring states, but no known searches have been made specifically to find additional populations and to assess the Yadkin Panicgrass in recent years other than a few in the Shawnee National Forest (Shawnee National Forest 2005). Suitable habitat for the subspecies appears to exist, but it appears that it may have never been common here.

Maintaining the shaded floodplain or moist forest habitat in which it grows appears to be one of the most important means to insure the survival (or viability) of this subspecies throughout its range. Its isolation and lack of specialized dispersal mechanisms appear to contribute to the very limited possibility for spread in *Dichanthelium dichotomum* subsp. *yadkinense*. There appears to be little chance of natural colonization of new habitat by this grass except, perhaps, in periods of major flooding. The long-term viability of this rare grass depends entirely on the protection and management of existing populations through human intervention.

POTENTIAL THREATS

Globally, the status of the Yadkin Panicgrass is unknown; it has not been determined to be either secure or vulnerable because it is often not recognized to be a distinct taxon. Instead, it is usually considered to be a variant (and the name a synonym) of the widespread and variable *Dichanthelium dichotomum,* known to be secure globally and not under threat. This subspecies may, with further study, be found to be somewhat vulnerable once its range is more fully understood and once the true number of populations and individuals has been determined.

Within Illinois, this grass has been judged to be vulnerable because it has a very limited state range and because there are very few reported populations remaining. It appears to be unable to increase its range.

The primary threats to this subspecies are thought to include clear-cutting, grazing, recreational use of its habitat (including equestrian use), encroachment by exotic plant species, and loss of habitat by changes in its hydrology (Shawnee National Forest 2005).

Clear-cutting in a floodplain or swamp forest habitat is generally known to dry out the understory, especially in southern latitudes, and many of these understory plants, such as the Yadkin Panicgrass, can succumb to the sudden drying and exposure resulting from these activities. Complete clearing or cutting of a forest stand could not be enacted where a colony occurs without adverse effects. Subsequent grazing by livestock is then likely to eliminate this grass from an area (Tilghman 1989). The panicoid grasses are very nutritious and they are sought out by grazing and foraging animals (Gould 1975).

The development of user-created trails, in particular equestrian trails, poses a threat to the few populations of this subspecies in Illinois. In 1992, one known population of this grass was extirpated from its original location at Double Branch Hole Ecological Area through the establishment of user developed horse trails (Shawnee National Forest 2005). Certainly any trampling or grazing of this rather delicate grass could quickly exterminate a small local population, and this appears to have happened in that case.

The most serious threat to this somewhat delicate understory grass is from changes in hydrology within its habitat. The draining of wetlands has been a serious threat to the native plants and animals in North America since the arrival of European settlers. Since settlement, much of the previously available habitat has been destroyed, converted to cultivated fields orchards or commercial forests, or has succumbed to land development (W-5). In more densely populated or industrialized areas, the lowering of the water table through the over utilization of water has had the same effect on wetlands. These threats are unlikely in or near the existing populations in Shawnee National Forest. However, because several sites are in the vicinity of canyons and gorges, the damming of an associated creek or river could extirpate local populations by drowning them.

Other threats may come from herbicide treatment along powerline clearings in these forested areas. The increased heat generated at open sites like these can severely suppress growth and prevent plant establishment as well. While overshading by woody species as forests mature is thought to be another potential threat to some understory plants, there is no data to support a loss of Yadkin Panicgrass plants as a result of dense shading. *Dichanthelium* species often grow in areas locally nearly devoid of other vascular plants, and they seem to grow well with ferns and

sedges in shade (pers. obs.). It is also reasonable to suggest that in its mesic to wet environment, *Dichanthelium dichotomum* subsp. *yadkinense* has not been dependent on fire management or on the presence of historic fires, but there is also no evidence to suggest that fires would hurt this grass either. It is generally thought that fires actually benefit populations of prairie and other light-loving grasses, though it is also known that species that normally grow in shaded habitats can decline or disappear when the shade is removed by fire or other means. Also, rhizomatous grasses are much better at surviving and profiting from a fire than are more delicate, shallow-rooted cespitose grasses such as many *Dichanthelium* species and subspecies.

Competition from shade tolerant exotic plant species (such as the vine *Lonicera japonica* and the grass *Microstegium vimineum*) may pose a threat to this rare grass in some areas, especially where the habitat has become somewhat disturbed. The Yadkin Panicgrass is certainly not an aggressive or competitive grass. *Dioscorea oppositifolia* (Chinese yam) may prove to be a serious threat because it has already been found several times in the vicinity of known populations of this rare grass. It also prefers the margins of creeks and streams. This and other aggressive exotic species can form dense stands and eliminate ground layer herbaceous species including this grass not only from excessive shading but also from monopolizing and removing the nutrients available in the habitat. Furthermore, exotic vines and woody plants can threatened the hydrology of some wetland environments by causing rapid evaporative loss of the water, and this could pose a threat to this grass as well. If such exotic species do become a factor in suppressing this rare grass, some limited fire management may become necessary (Shawnee National Forest 2005).

Because of the fragmentation and variable use of habitat resulting from a mix of public and private land ownership in the area where it grows, a strong effort should be made to add to the buffer around existing colonies and their habitats. It is likely that this subspecies is sensitive to cropland chemical runoff such as herbicides, and that agricultural fertilizer or nutrient runoff will increase the success of aggressive exotic weeds in the environment. Both problems are well known to be threats to rare plants and plant communities. Care would be needed to prevent such pollutants from entering the habitat of the Yadkin Panicgrass.

It is generally believed among biologists that habitat fragmentation can have profound effects on the success and persistence of local populations. Over time, as populations become increasingly more isolated, the effects of fragmentation can potentially be observed at the molecular level by reduced genetic frequencies caused by random drift (Barrett and Kohn 1991). When one is considering populations that are already isolated, as in the case of the Illinois populations of this mostly self-pollinating grass, random genetic drift may have already occurred and it may have already caused negative effects to the subspecies.

At the current time, it appears that the few populations of *Dichanthelium dichotomum* subsp.

yadkinense in the Shawnee National Forest are protected from habitat change and that they are likely to persist. However it is also clear that because there are so few populations now known, extirpation of some colonies could occur from the use of new user created trails.

RESEARCH AND MONITORING

Considerable research is needed on the Yadkin Panicgrass to gain a better understanding of it and its needs. At this time, one of the primary needs is to determine its current and historical range by the examination of herbarium specimens of this and similar species and subspecies that may have been incorrectly identified or that were collected before this subspecies was accepted as being distinct. Research needs include continued and additional searches for additional populations to re-evaluate the plant's status. Fieldwork is an integral part of the research plan.

Research is needed on the basic life history of this grass. Specific details are not known concerning its fertility, dispersal mechanisms, germination and establishment requirements, growth rates, and genetic health (including variability). Herbarium specimen data might suggest that the autumnal phase of this grass is far less important than the vernal phase of the grass, and so few seeds are actually produced, but this observation is based upon a very small sample size and so it is inconclusive. It would be useful to know how long the seeds are viable and how many must be in the seed bank to insure the survival of a colony. Also of major importance is basic data on how this grass responds to fire. Because some states have very few populations of this grass, caution is needed during field research to avoid harming the colonies. Some limited research on prescribed fire or selective thinning of the canopy should be conducted in order to determine the effects of increased light levels to the habitat and populations for the purpose of potentially better management (W-5). There is a need to determine the best habitat for this grass and how to best maintain the character of these areas (W-5).

Some populations of *Dichanthelium dichotomum* subsp. *yadkinense* are being monitored currently by botanists working on behalf of the state Natural Heritage program and the National Forests in the areas where it is listed as endangered or at risk (Shawnee National Forest 2005; Herkert and Ebinger 2002). Periodic monitoring is needed not only to supply data on its life history, but also to determine the threats to its habitat caused by water runoff and excess water, chemical pollutants in that runoff, edge effects such as drying, habitat destruction, and by exotic species wherever this subspecies occurs. It is generally recommended that the habitat quality where this plant grows should be monitored on a regular basis and an assessment of the specific threats to all populations should be made (W-5; Webb *et al.* 1975). Long-term monitoring of known populations should be conducted every 1-2 years to track their status with respect to these current management activities. Population stability, reproduction, and vigor should all be monitored. While hydrology and humidity fluctuations are assumed to occur in its habitat, it is not known precisely how much fluctuation can occur without adversely affecting the plants. It is

also not known how well this grass can be established in newly created forested sites, though it is probable that it could be successfully introduced to former sites as well as to mitigation sites if necessary.

Another important consideration is the unknown effect of prolonged or continuous foraging on this grass by deer or other mammals. It is possible that it is selectively eaten – but there is no data to support this. An enclosure (animal exclosure) around a colony along with a careful inventory for several years would be a simple way to test this hypothesis (Tilghman 1989). Related to this, the incursion of horses or other livestock into its habitat can pose a serious and immediate threat to the small colonies of this grass, as experience has shown.

Previous research on other species in the vicinity of floodplains has shown that the conditions within entire watersheds where the plants grow must be taken into consideration (W-5). It is not known exactly how much disturbance can occur before an individual population is adversely affected, nor is it known how large a wetland is needed in its proximity to support a viable population. Monitoring of the nearby wetlands may assist in determining the health of each population once it is known exactly what the environmental parameters should be for optimal growth.

Population data for this grass is made more difficult by the fact that it is sometimes difficult to identify or to distinguish it from related species and subspecies. Local species growing with it should all be identified and distinguished before any research on the Yadkin Panicgrass can begin, because this grass is known to associate with other very similar *Dichanthelium* species. Positively identified clumps should be carefully marked with fireproof markers that will last long enough for repeating observations over several years. A mix-up in labels with other very similar species or subspecies in the same vicinity can result in useless data, and this could be an especially serious problem in studies of this grass. Once the plants are carefully identified and marked, then one can determine how many distinct plants actually occur at a given site. Subsequently, information can be gathered on how many genetically distinct individuals may actually occur at a site, as well as on seedling establishment and success. Only careful molecular investigation can ultimately determine the number of genotypes in any given population, and this data will be useful in determining the extent of population inbreeding and the degree of genetic variability present in the Illinois populations.

Periodic surveys will be needed to determine the health and productivity of the population by counting the numbers of individuals. This is the only means to determine population trends accurately (W-5). Reproductive success can be estimated by counting the number of fruiting stems or fruiting tufts produced each season because seedlings and young plants cannot easily be identified in the field. Therefore, as part of the basic research on current populations of this subspecies, data such as the counts of numbers of individuals present (or the area covered by the

colony), the determination of the amount of yearly flowering and seed production that might occur, and an assessment of recruitment rates are needed in order to monitor population dynamics and to assess the viability of the individual populations found. Individual plants should be monitored over time at each site for basic phenology data. Such basic facts as fungal associations (if any), longevity, and yearly variations in colony size over a long period are not precisely known.

Dichanthelium dichotomum subsp. *yadkinense* is so poorly understood and ignored by all but a few skilled botanists that a primary emphasis should be to locate and vigorously protect all remaining populations. It is crucial, of course, to have the identifications confirmed by a specialist in the group. Similar habitat should be explored for the plant at its flowering and fruiting seasons. There are moderate areas of additional suitable habitat in southern Illinois where the grass could also exist. A tentative list of associates and indicator species has been compiled as a result of field studies in Illinois and other states (see Habitat section above). These indicator plants can be very useful in facilitating the discovery of additional populations of this grass. Fruiting material is normally needed for positive identification of this grass, but mature seeds may not be necessary. Particular attention should be made to search and / or monitor this grass at its peak period for fruiting in one's local area, normally in mid June to mid July for the spring phase, and in early to mid September for the autumnal phase. Because of the general difficulties in identifying this grass, voucher specimens should be made according to techniques described in Hill (1995) or other similar references. It is quite possible that populations of this subspecies have been overlooked because of the difficulties in field identification as well as because of the lack of adequate voucher material with which to compare specimens.

Botanical surveys conducted by scientists from the Illinois Natural History Survey and elsewhere have shown repeatedly that with sufficient time and funding, and an experienced eye, many plants thought to be extirpated or else threatened or endangered occasionally can be found at additional locations (Hill 2002). These sorts of investigations have been important in that they have led not only to the de-listing of species once thought to be rare, but they have also resulted in the discovery of species previously unknown in the state. The U.S. Forest Service and other related agencies have done a fine job in the effort to preserve rare species with the resources that they have available. Much of the locating and monitoring of known populations of rare species in southern Illinois has been conducted by Forest Service biologists and students in cooperation with Illinois Department of Natural Resources personnel. However, a continuing problem is that there is neither sufficient funding nor are there enough botanists available to survey the immense area that needs to be covered in the monitoring of the large numbers of sensitive plants, including this one. It appears that a high priority should be given to the training and hiring of more qualified field botanists to achieve these goals.

RESTORATION

There are no known restoration efforts being conducted on *Dichanthelium dichotomum* subsp. *yadkinense* anywhere in its range and the restoration potential of this subspecies is largely unknown (W-5). Observations on this and related grasses have indicated that successful fruit production in this subspecies does occur, and that reproduction may be primarily by seed. It is also presumed that the restoration potential of this and many other grasses is good (W-4).

As stated previously, the generally recommended method to restore populations of this and other rare plants is to protect and manage their habitat. In the previous section, the protection of the hydrology was said to be especially critical for the survival of this grass. The control of access to the known sites by hikers and horses appears to be equally necessary for any restoration attempt. Exotic and aggressive species should be eliminated from each site. This would entail physically pulling them out because it is very likely that herbicide application would eliminate this subspecies at a site as well. The use of controlled burns, the thinning of the overstory, and the thinning of competing understory species are as yet untested means of managing for this plant, and some caution should be given to these methods until more data has been obtained on their effects.

Restorations of any native plant species are recommended using only propagated material grown from native, local populations to avoid mixing genotypes not adapted to the local conditions and to avoid compromising the local gene pool. If this rule is not followed, the result is generally the loss of plants because the non-native forms may not be competitive under local conditions or the result could be the success of a plant or plants that cannot be considered truly native (considered by some to be a plant community reconstruction rather than a restoration). Local plants should be propagated for planting in such an effort. Grasses are normally easily propagated by means of fresh seeds and / or simple division (pulling apart dense stem clumps) under controlled conditions.

This grass is not known in cultivation and it is not commercially available in this country.

In summary, the restoration management for extant colonies of *Dichanthelium dichotomum* subsp. *yadkinense* should include the monitoring and management of the hydrology within its habitat, the prevention of logging and recreational uses in its vicinity, the monitoring and possible exclusion of grazing and browsing mammals in its vicinity, the experimental investigation of management techniques such as the use of prescribed fire or the selective thinning of the canopy in order to maintain suitable light levels for growth and flowering, and the elimination of woody plant encroachment in the understory, particularly that of exotic species. Habitats also need protection from land development and from indiscriminate herbicide application as well as from possible agricultural chemical runoff that may pollute its habitat. At

this time, with proper management, current populations should persist and they could even increase in size, but the establishment of additional populations will be only through active human efforts.

SUMMARY

The Yadkin Panicgrass, *Dichanthelium dichotomum* subsp. *yadkinense* (= *Dichanthelium yadkinense*) is not always recognized as a distinct plant, instead, it usually has been thought of as a part of the variable species *Dichanthelium dichotomum*. When considered distinct, it is defined as a clumped perennial grass up to approximately 1 meter tall with rather broad spring leaves, and it is normally found in moist or wet sandy soils in shade in floodplain forests or low upland forests near creeks in twenty-one states ranging from Pennsylvania and Illinois south to Florida and Texas. The plants have a spring-flowering stage and a morphologically different late summer and autumn flowering stage, they have a series of distinct pale glands on their leaf sheaths, and they have a wide-leaved basal rosette in the winter months. While normal wind-pollinated flowers are present in the spring, late summer flowers self-pollinate and normally do not open. This grass has been listed as Endangered in Illinois (as *Dichanthelium yadkinense*) and Ohio (as *Panicum yadkinense*), as Threatened in Indiana (also as *Panicum yadkinense*), and as At Risk (as *Dichanthelium yadkinense*) in the Shawnee National Forest of Illinois, the Hoosier National Forest in Indiana, and the Mark Twain National Forest in Missouri.

A great deal of additional basic research is needed to better evaluate the status and distribution of this grass. Suggested research priorities for this rare grass include attempts to locate additional populations, to determine population sizes and to set up long-term monitoring stations, and to determine, through controlled and cautious experimentation, the best management techniques to insure its survival and increase. Management through enforced protection of its habitat appears to be necessary to allow it to persist where it may occur.

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CONTACTS

Shawnee National Forest, Hidden Springs Ranger District, 602 N. 1st Street, Vienna, IL 62995

Elizabeth Longo Shimp (618) 658-2071; e-mail: eshimp@fs.fed.us

Shawnee National Forest, Mississippi Bluffs District, 521 N. Main Street, Jonesboro, IL 62952

Stephen P. Widowski (618) 833-8576; e-mail: swidowski@fs.fed.us

Hoosier National Forest; 811 Constitution Avenue, Bedford, IN 47421

Kirk Larson (812) 275-5987

Steven D. Olson (719) 553-1400; e-mail: solson01@fs.fed.us
Currently: Pike-San Isabel National Forests,
Cimarron-Comanche National Grasslands,
Kachina Drive, Pueblo, CO 81008

Illinois Natural History Survey, 1816 S. Oak Street, Champaign, IL 61820-6970

Dr. Steven R. Hill (217) 244-8452; e-mail: srhill@mail.inhs.uiuc.edu

Illinois Endangered Species Board

Dr. John E. Ebinger (217) 345-3815; e-mail: cfjee@eiu.edu

Indiana Department of Natural Resources, 402 W. Washington St., Indianapolis, IN 46204

Michael A. Homoya (317) 232-0208; e-mail: mhomoya@dnr.state.in.us

Biological Consultant

John E. Schwegman (618) 543-9429; e-mail: botany@wkblue.net

Missouri Botanical Garden, P.O. Box 299, Saint Louis, MO 63166-0299

Dr. George A. Yatskievych (314) 577-9522; e-mail: george.yatskievych@mobot.org

APPENDIX 1

Representative specimens of *Dichanthelium dichotomum* subsp. *yadkinense* examined or cited in the literature

Herbaria:

ILLS = Illinois Natural History Survey, Champaign. MISS = University of Mississippi, University, Mississippi. MO = Missouri Botanical Garden, St. Louis. OS = Ohio State University, Columbus. US = U.S. National Herbarium, Smithsonian Institution, Washington, D.C. WIS = University of Wisconsin, Madison.

NOTE: Few specimens in herbaria bear this name because subsp. *yadkinense* is infrequently accepted as distinct; therefore, only those reliably thought to be this taxon are included below. Identifications may not be accurate in some cases, but it is thought that most are correct. MO specimens, for example, were filed within *Dichanthelium dichotomum* (L.) Gould. Specimens that were annotated with the name '*yadkinense*' at any rank were recorded. Most specimens had the diagnostic conspicuous circular flat lenticel-like (wart-like) glands on lower culms and leaf sheaths. Those annotated by Chase, of Hitchcock and Chase (1951) bear the initials "H&C" below and her annotation labels also included the note: "Revision of *Panicum*. Hitchcock & Chase". These were identified as *Panicum yadkinense* Ashe. In a few cases, an identification history has been provided. "det." = identified, or determined, by.

ALABAMA: BALDWIN CO., Tensaw, det. Tracy as *Panicum yadkinense*, 18 Aug 1904, *Tracy 8029* (MO).

ARKANSAS: HEMPSTEAD CO., near McNab, det. Palmer as *Panicum dichotomum* and by unknown as "cf. *P. yadkinense* Ashe - pale glandular spots on sheathes. [but] Spikelets a little short, not quite pointed.", 31 Jul 1933, *Palmer 42070* (MO).

DISTRICT OF COLUMBIA: Wildwood Junction, Takoma Park, det. House as *Panicum yadkinense* Ashe, conf. H&C, 1 Jun 1905, *House 911* (MO).

GEORGIA: LAURENS CO., in swamp of Oconee River opposite Dublin, det.: H&C as *Panicum yadkinense*, 20 Jun 1902, *Harper 1349* (MO).

ILLINOIS: MASSAC CO., thicketed slope, 7 mi NW of Metropolis, 18 May 1932, *Pepoon & Barrett 762* (ILLS – tentative ID by Hill 3/2007); **POPE CO.**, the big seep at Cretaceous Hills Nature Preserve, open sunny acid seep, 16 May 2005, *Schwegman s.n.* (ILLS – tentative ID by Hill 3/2007); creek bank, Hayes Creek Canyon N of Eddyville, 9 Jul 1963, *Evers 76936* (ILLS –

tentative ID by Hill 3/2007); Belle Smith Spring, woods along creek, SE of McCormick, 24 Jul 1956, *Evers 51603* (ILLS – tentative ID by Hill 3/2007).

KENTUCKY: ELLIOTT CO., along Ison Creek, W of Stephens, det.: Reed as *Panicum yadkinense*, 25 Jun 1982, *Reed 115833* (MO).

MARYLAND: ANNE ARUNDEL CO., Grays Creek, just N of Gibson Island, det. Swallen as *Panicum yadkinense*, 7 Jul 1951, *Reed 25965* (MO); **MONTGOMERY CO.**, West Chevy Chase, det.: H&C as *Panicum yadkinense*, 11 Jun 1905, *Hitchcock s.n.* [*106*] (MO); Plummers Island, 4 Jul 1937, *Killip & Swallen 32140* (US); Plummers Island near Cabin John, 6 Jun 1905, *Hitchcock 12773* (US); PRINCE **GEORGES CO.**, Somerset Hill, det.: Newbold as *Panicum yadkinense*, 16 Aug 1922, *Newbold 1217* (MO); Takoma Park, along Sligo Creek, det.: H&C as *Panicum yadkinense*, 19 Jul 1915, *Chase 6987* (MO).

MISSISSIPPI: PERRY CO., Ragland Hills Natural Area, 27 May 1970, *Rogers 3359-B* (MISS).

NORTH CAROLINA: BUNCOMBE CO., Biltmore, det.: Boynton as *Panicum yadkinense*, conf. H&C, 1906, *Boynton 3* (MO); same data, *Boynton 2* (MO).

OHIO: JACKSON CO., Liberty township, *Bartley & Pontius* (OSU); **SCIOTO CO**., Shawnee State Forest, Camp Gordon C.C.C., Friendship, det. by Demaree as *Panicum yadkinense*, 7 Jun 1934, *Demaree 11703* (MO).

SOUTH CAROLINA: GREENWOOD CO., Saluda River, near U.S. 25, 6 Jun 1964, *Freckmann 1212* (WIS).

TENNESSEE: CHEATHAM CO., by Big Marrowbone Creek ca. 1.5 mi SE of Ashland City, 6 Jun 1966, *Kral 26794* (WIS).

VIRGINIA: DINWIDDIE CO., bottomland of Rowanta Creek, near Rowanta, det.: Fernald as *Panicum yadkinense*, 8 Jun 1938, *Fernald & Long 8070* (MO); **HALIFAX CO.,** 1.9 miles W of the Staunton River bridge along U.S. 360, 29 May 1964, *Freckmann 1556* (WIS); **SOUTHAMPTON CO**., bottomland of Nottoway River, Courtland, det.: Fernald as *Panicum yadkinense*, 24-25 Aug 1936, *Fernald & Long 6485* (MO); **SUSSEX CO.**, east of Stony Creek, det.: Fernald as *Panicum yadkinense*, 17 Jul 1939, *Fernald & Long 10497* (MO).

APPENDIX 2.

The Historic Distribution of *Dichanthelium dichotomum* subsp. *yadkinense* in the United States.
Information from herbarium specimens and the literature.
(If in > 10 counties, then only number of counties included.)

NOTE: Only the states from which this subspecies (at any rank) has been reported are included here. The distribution of *Dichanthelium dichotomum* in the broad sense has not been included unless otherwise noted, and states where the typical variety occurs but not the subsp. *yadkinense* have been excluded. The subspecies is thought to be much more widespread than indicated below – this is a conservative list. See notes provided in Appendix 1 for more detail.

STATE	COUNTIES	NOTES
Alabama	subsp. *yadkinense*: Baldwin	Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Arkansas	subsp. *yadkinense*: Hempstead.	Herbarium specimens; Smith (1979) [lumps all subsp. into *Panicum dichotomum* L., listing *P. yadkinense* as synonym].
Delaware	subsp. *yadkinense*: present, distribution unknown.	McAvoy (2003); Hitchcock and Chase (1951; as *Panicum yadkinense*).
District of Columbia	subsp. *yadkinense*: present [Takoma Park]	Herbarium specimens.
Florida	subsp. *yadkinense*: Glades, Highlands, Okeechobee, Osceola, Polk	Orzell and Bridges (2006); Hitchcock and Chase (1951; as *Panicum yadkinense*).
Georgia	subsp. *yadkinense*: Chatham, Coffee, Laurens, Lumpkin, Rabun, Screven	Jones and Coile (1988); Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).

Illinois	subsp. *yadkinense*: generally accepted to be in Johnson and Pope cos.; unconfirmed reports also from Gallatin, Hardin, Jackson, Massac, Pope, and Union cos.	Mohlenbrock & Ladd (1978) [as both *Panicum dichotomum* and *Panicum yadkinense*]; Mohlenbrock 1986 [as *D. yadkinense*]; Hitchcock and Chase (1951; as *Panicum yadkinense*). Herbarium specimens. Includes Shawnee N.F.
Indiana	subsp. *yadkinense*: Crawford, Daviess, Jackson, Lawrence, Martin, Perry	Deam (1940 as *Panicum yadkinense*); Homoya (pers. comm.); Hitchcock and Chase (1951; as *Panicum yadkinense*).
Kentucky	subsp. *yadkinense*: Elliott	Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Louisiana	subsp. *yadkinense*: Livingston, St. Tammany parishes	MacRoberts (1989) [as *Dichanthelium dichotomum* var. *dichotomum*]; Thomas & Allen (1993) [as *Panicum dichotomum* var. *dichotomum* and *P. dichotomum* var. *yadkinense*]; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Maryland	subsp. *yadkinense*: Anne Arundel, Montgomery, Prince Georges	Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Mississippi	subsp. *yadkinense*: Perry	Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Missouri	subsp. *yadkinense*: Reynolds	Heumann (1993); Yatskievych (1999); including Mark Twain N.F.
New Jersey	subsp. *yadkinense*: present (historic), distribution unknown.	W-3; Hitchcock and Chase (1951; as *Panicum yadkinense*).

North Carolina	subsp. *yadkinense*: Buncombe, Cumberland, Harnett, Henderson, Hoke, Moore, Wake, Yadkin	Sorrie *et al.* (2006); Radford *et al.* (1968) [as *Panicum dichotomum*]; Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Ohio	subsp. *yadkinense*: Jackson, Scioto	W-4; Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Pennsylvania	subsp. *yadkinense*: Chester, Delaware, Fayette, Montgomery, Philadelphia	Pohl (1947); Rhoads and Block (2000) [as *Panicum yadkinense*]; Hitchcock and Chase (1951; as *Panicum yadkinense*).
South Carolina	subsp. *yadkinense*: Clarendon, Greenwood	W-12; Radford *et al.* (1968) [as *Panicum dichotomum*]; Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
Tennessee	subsp. *yadkinense*: Blount, Cheatham, Cumberland, Dyer, Fentress, Maury, Moore, Polk [widely scattered, no particular concentration].	Chester *et al.* (1993); Estes and Walck (2005); Hitchcock and Chase (1951; as *Panicum yadkinense*).
Texas	subsp. *yadkinense*: present, distribution unknown.	Hitchcock and Chase (1951; as *Panicum yadkinense*).
Virginia	subsp. *yadkinense*: Bland, Charlotte, Craig, Dinwiddie, Halifax, Isle of Wight, Montgomery, Prince William, Southampton, Suffolk, Sussex, Tazewell.	W-13; Herbarium specimens; Hitchcock and Chase (1951; as *Panicum yadkinense*).
West Virginia	subsp. *yadkinense*: present, distribution unknown.	Hitchcock and Chase (1951; as *Panicum yadkinense*).

APPENDIX 3.

Natural Diversity Database Element Ranking System

Modified from: http://www.natureserve.org/explorer/ranking.htm [W-10]

Global Ranking (G)

G1
Critically imperiled world-wide. Less than 6 viable elements occurrences (populations for species) OR less than 1,000 individuals OR less than 809.4 hectares (ha) (2,000 acres [ac]) known on the planet.

G2
Imperiled world-wide. 6 to 20 element occurrences OR 809.4 to 4,047 ha (2,000 to 10,000 ac) known on the planet.

G3
Vulnerable world-wide. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac) known on the planet.

G4
Apparently secure world-wide. This rank is clearly more secure than **G3** but factors exist to cause some concern (i.e. there is some threat, or somewhat narrow habitat).

G5
Secure globally. Numerous populations exist and there is no danger overall to the security of the element.

GH
All sites are historic. The element has not been seen for at least 20 years, but suitable habitat still exists.

GNR
Not ranked globally. The element is not known sufficiently or there is some question as to its ranking at the current time.

GX
All sites are extirpated. This element is extinct in the wild.

GXC

Extinct in the wild. Exists only in cultivation.

G1Q
Classification uncertain. The element is very rare, but there is a taxonomic question associated with it.

National Heritage Ranking (N)

The rank of an element (species) can be assigned at the national level. The **N-rank** uses the same suffixes (clarifiers) as the global ranking system above. **NNR** = not ranked nationally.

Subspecies Level Ranking (T)

Subspecies receive a **T-rank** attached to the G-rank. With the subspecies, the G-rank reflects the condition of the entire species, whereas the T-rank reflects the global situation of just the subspecies or variety. **TNR** = not ranked at the taxonomic level in question. While rarely used, the rank of **TU**, tentatively undetermined, apparently indicates that the taxonomy of the entity is unknown, or questionable.

For example: *Chorizanthe robusta* var. *hartwegii*. This plant is ranked **G2T1**. The G-rank refers to the whole species range (*i.e.*, *Chorizanthe robusta*, whereas the T-rank refers only to the global condition of var. *hartwegii*. Otherwise, the variations in the clarifiers that can be used match those of the G-rank.

State Ranking (S)

S1
Critically imperiled. Less than 6 element occurrences OR less than 1,000 individuals OR less than 809.4 ha (2,000 ac). **S1.1** = very threatened; **S1.2** = threatened; **S1.3** = no current threats known.

S2
Imperiled. 6 to 20 element occurrences OR 3,000 individuals OR 809.4 to 4,047 ha (2,000 to 10,000 ac). **S2.1** = very threatened; **S2.2** = threatened; **S2.3** = no current threats known.

S3
Vulnerable. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac). **S3.1** = very threatened; **S3.2** = threatened; **S3.3** = no current threats known.

S4
Apparently Secure. This rank is clearly lower than S3 but factors exist to cause some concern (*i.e.*, there is some threat, or somewhat narrow habitat).

S5
Secure. Demonstrably secure to ineradicable in the state.

SH
All state sites are historic; the element has not been seen for at least 20 years, but suitable habitat still exists. Possibly extirpated.

SNR, SU, S?
Reported to occur in the state. Otherwise not ranked.

SX
All state sites are extirpated; this element is extinct in the wild. Presumed extirpated.

Notes:

1. Other considerations used when ranking a species or natural community include the pattern of distribution of the element on the landscape, fragmentation of the population/stands, and historical extent as compared to its modern range. It is important to take a bird's eye or aerial view when ranking sensitive elements rather than simply counting element occurrences.

2. Uncertainty about the rank of an element is expressed in two major ways: by expressing the rank as a range of values (*e.g.*, **S2S3** means the rank is somewhere between **S2** and **S3**), and by adding a '**?**' to the rank (*e.g*. **S2?**). This represents more certainty that the rank is **S2** than **S2S3**, but less certainty than **S2** alone.